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An account of the increase of Weight in Oyl of Vitriol expos'd to the Air.

Since the Excellent *Mr. Boyle* has made the *Air* a Subject of his Observations, the Learned World is sufficiently taught how vast a share it has in producing many effects, which Philosophy never so much as dreamt of before; and if, upon the hint experiment has given us, we reflect on the infinite variety of *steams* constantly emitted from all sorts of Bodyes into the *Atmosphere*, which are there *diffolv'd* as it were in a common *Menstruum*; we have reason to expect therein *particles* enough of all *shapes, sizes* and *motions* fit and proper to alter the *texture, diminish or increase* the *Bulk* and *weight*, of almost any *body* expos'd to its action.

As to the *Increase of Weight* (the busines in hand) we know how bodies Rob'd of some constituent parts by fire (as *quicklime* and *all calxes*) slacken and greedily *imbibe* something from the *Air*; and the like is observ'd in the *caput mortuum*, of *Salt*, *Nitre*, *Alum* and *Vitriol*. On the same score all *fixt Salts* run into a fluid *per diliquum*; Tis the *Air*, that in *seven years* ful'y reimpregnates the earth heap't up in the shade whence *Nitre* was before extracted; tis the *Air* that causes the *Efflorescence* of *Marcaites* and *Vitriol-stones*; tis the *Air* that by its *acid* turns the *lead* of old buildings into *Cerusse*, which without doubt increases in *VWeight*, (as that made by fire does) which is asserted to be at the rate of six or seven pound in an hundred. The same *Growth of Metals* seem to acknowledge the same origine, and there are *none* (Gold it self not excepted) but what *Agricola*, *Gerhardus* and some other *Metallick WRiters* observe to have *increas'd* considerably by the free accessse of *Air* to the *Shaft's* and *Grove's*; and the very heaps of *Rubbish* wash't from *Tin Oar's* here in *England* have within the memory of man, nay in 10 or 12 years been wrought over again with great advantage:

now

now though we must perhaps acknowledge in some of these Instances, that the particular *seminal principle* specifies these new aquir'd parts; and determinately makes them *Mineral* or *Metallick* of the name and nature of the *Matrix* into which they are received, yet this is certain; the addition of *weight* is owing to a *Substance* communicated by the *Air*. Instances of this nature concerning the *growth* of Lead, Iron, Tin, Silver and Gold with the *Increase* of other bodies are succinctly collected and with his wonted *Sagacity* remarkt on by Mr *Boyle* in his tracts on that subiect. So that the *Increase* and *attractive power of Solids* is a Theme already fairly cu'tivated and put beyond question: But that *liquids* such as seem *Saturated* with their *own moyiture* should neverthe'efs imbibe *more* from the *Air* is not mentioned by any Author I know of, except the aforesaid *Learned person*, who in his Tract of *Aerial magnets* advices tryals upon the *liquid preparations of Vitriol*: I have heard indeed some Druggists have accidentally taken notice of this encrease in *Oyl* of *Vitriol*, (and perhaps have improv'd it to their *own gain* though to the detriment of the buyer,) but the observation never was prosecuted with any method or certain account how much the said *Increase was*, and *what the substance, gain'd*.

The Industrious Chymist Mr. *VWhite* our University Operator, having a *Viol* of that liquor *unstoppt* and constantly *running over*, first gave occasion to the following notes: but since from thence no true estimate of the just *Increase* could be collected, I hope it may not prove altogether ungrateful to the *Curious* to give you, in answer to your request, what has occur'd more particularly on this subiect, and I do it the more readily because the *R. S.* have thought it a thing not to little for the pres.

On the ninth of No. 1683. ThreeDrams of *Oyl* of *Vitriol* so far Dephlegm'd as to burn or *Corrode* a strong pack-

thred assunder, was expos'd to the *Air* in a *Marmalade Glass* of *three Inches* Diameter, and plac't in a nice pair of Scales, in a Room where no fire nor Sun came; Its *Increase* for *7 natural days* divided by *less* portions of *time* was according to the following Table.

A TABLE.

D. Hour.	Gain.	Space of time.	Weath.	Wind.	Sum of gain.	Natural Day.
9 spom.	Dr. 0 Scr. 0	H.	Souther-	Dr. Scr. Gr.		
11 pom.	gain 0 scre 12	6	Moist, Moist & Windy,	ly.	1 0 8	1 st .
10 8 mat.	1 12	9	Rainy Morn.	N. We-		
11 1 mat.	0 8	3	Clear.	sterly.		
5 pom.	0 9	6				
11 pom.	0 18	6	Starlight. Cold.			
11 8 mat.	1 7	9	Bright Morn. mild.	N. VV.	0 2 18	2 ^d .
11 1 mat.	0 4	3	Mild dry wea-			
5 pom.	0 9	6	ther.			
11 pom.	fere 0	10	Mild dry	N. VV.	Dr. Scr. Gr.	
12 8 mat.	0 17	9	clear Morn.	North.	0 1 19	3 ^d .
11 1 mat.	0 5	3	Frosty.	N. more		
5 pom.	0 7	6	Overcast	VWest.		
11 pom.	0 6	6	Cloudy Rain	VWest- ly.	Scr. Gr.	
13 8 mat.	0 9	9	Cloudy mild.	South- west.	1 3	4 ^d .
11 1 mat.	0 3	3				
5 pom.	0 5 $\frac{1}{2}$	6				
11 pom.	0 6	6	Cloudy moist	South- east.	Scr. Gr.	
14 8 mat.	0 8	9	Cloudy misty		0 18	5 th .
11 1 mat.	0 2 $\frac{1}{2}$	3	Misty	Souther-		
5 pom.	0 1 $\frac{1}{2}$	6	Very Warm.	ly.		
11 pom.	0 2	6	Cloudy unu- ally warm.	more South	Scr. Gr.	
15 8 mat.	0 6	9	Cloudy.	South East	0 15	6 th .
11 1 mat.	0 3	3	Cloudy moist.	more South		
5 pom.	0 4	6	Clear Coldish.	Easterly.		
11 pom.	0 4 $\frac{1}{2}$	6	Dry Starlight	Easter-	Scr. Gr.	
16 9 mat.	0 9	10	Cold, Cloudy but Cold	ly.	0 17	7 th .
11 1 mat.	0 2	2	Cloudy Windy	South-		
5 mat.	0 2	6	Cloudy very mild.	east.		

From

From the 16th. in the successive spaces of twenty four hours, each gain'd one of the number of Grains following, as the 8th. natural day gain'd 13 $\frac{1}{2}$, the next 12, 9, 7, 6, 5, 5, 4 $\frac{1}{2}$, 3, 3, 3, 3, 4, 3. (December) 4, 4 $\frac{1}{2}$, 4, 3, 3, &c. still irregularly decreasing till the liquor was satiated.

But these *seven days*, here specified in the *Table*, containing all the considerable variety to be observ'd in this busines, it would be *superfluous* and impertinent to trouble the Reader with any longer Diary, which was kept to the 4th. of *January 1681*; when the Increase in 24 hours amounted scarce to *half a grain*, and probably had the weather been then dry, it might have been none at all, or rather the liquor might have *lost* what before it had *gain'd*; as I shall observe by and by to some other purpose. But what is obvious to discourse upon the whole, relates either to the *Manner, Causes, Substance, Quantity* and *Time* of the *Increase*, or to the *Use* that may be made of the experiment in order to the discovering of the *changes in the Air*.

As to the first, the *more* our liquor was Saturated, the *less* was its dayly increase, though not *gradually* less by an even descent each day, but sometimes 2 or more natural days together it was exactly the *same*, a day or two after *less* and then *again more* the next day following according as the liquor stood affected by the heat or cold, drynes or moisture of the weather, the differing time of the day and quarter of the Wind. Thus upon the view of the whole Diary of almost two months; it appear'd, the increase was *more* in a Moist, Rainy, Misty, and Snowy, but *less* in a Frosty, Clear, and Dry Season, as also was *more* in a Cold than in a Warm Air.

When the Wind was Northerly or Easterly the gain was *less cæteris paribus* than when Southerly or Westerly, and was *less* in the day than in the night.

The primary cause of this *Phænomenon* seems to be the *Moisture of the Air*, which our liquor (a potential fire) im-

imbibes as greedily, as *actual fire* does the pabulum of Nitre, yet we must allow that all the other *Circumstances of Season* just now mention'd have each their particular influences in diversifying the *quantity* of the *Increase*. Thus it appears in the *Table* that *heat* alters the *progress* of increasing: For on the fourteenth day of *November* from 11 *mat.* to 11 *pom.* (at which time specially towards night) a very unusual and troublesome heat in the Air was complain'd of by several here in *Oxford*) in twelve hours the gain was only three Grains and $\frac{1}{2}$; whereas in the like time preceeding 'twas 10 Grains and $\frac{1}{2}$, and in that just following 9 Grains.

Neither indeed can any thing otherwise be expected from *Heat*, since thereby the *Moisture* might rather be exhal'd; or at least might be suspended, agitated and intimately *mixt* with the *substance* of the Air, and consequently not so easily be *Arrested* and *Entangled* by the surface of the Liquor, as when the Air is less hot. How ever allowing the effect of this *anomalous accident* at a time of the year when *least* expected, and considering that most commonly *Heat* keeps even pace with the *Season* of the year, depending as to its temper for the most part on the *Nearness* or *Remoteness* of the Sun; we may safely conclude *Moisture* the cheif and only *cause* of the *Increase of Weight* in *Oyl of Vitriol*, since in *Dry*, *Clear* weather it constantly increases less than in *Moist* and *Cloudy*, the circumstance of *Heat* or *Cold* remaining the same in both.

But this will be clearly evinced by an enquiry made into the *nature* of the *substance* gained, with the *Increase of Weight*. For by the ordinary wayes of tryal it appear'd the *Atmosphere* afforded our liquor nothing besides some of its *matry* particles, wherewith it always abounds, but more especially is ready to part with in *Moist* weather.

The *Air* without doubt has great variety of *different Substances* floating in it, whereof *some* particles do ad-

here

here to this, some other sort to that body, according as either is peculiarly dispos'd to receive one sort rather than another. Thus the Mortar in the Joints of old Walls and Vaults from Corpuscles attracted from the Air, Sprouts out and frames a peculiar kind of Salt. I have known a Deal Shelfe moisten'd only with the Liquor of fixt nitre, frosted over with Christals of a perfect inflammable nitre by regaining the proper acid from the Air, all one as if so much Spirit of nitre had been pour'd on the said Liquor; I have seen a Viol half fill'd with Oyl of Tartar per deliquium (by being left open to the Air,) belet above the Liquor with peculiarly figur'd Crystalls, and at the bottom were flat Christaliz'd plates of a Salt which without flame crackled on a live Coal and left behind a Calx much like Dr. Lyfters nitrum Calcarium. And tis well known Colcothar of Vitriol reimpregnated by the Air, will by a fresh distillation give you its proper Acid as at first. Now upon such hints as these, some (fond of the doctrine of Alcali and Acid) might perhaps expect, since differing Bodies of an Alcalizate nature do thus regain their proper acids, that vice versa even this most acid Liquor Oyl of Vitriol also might find its Alcalizate associate in the Air, from which the violence of fire had before driven it, but we could discover no such matter; the tast of our augmented Liquor was still purely acid and only weaker than before, whereas it would have been Saltish had an Alcali been combin'd with it, and its colour from a deep reddish, became limpid, all one as if the like quantity of fair water had been mixt; but to be more certain in this point I distill'd off the new gain'd Substance, at first it came over as insipid as clear water; and urging the fire farther, the drops prov'd sour, the remaining Oyl in the Retort was altogether as Corrosive as at first, whence we may infer its Edge was not at all blunted by any adjoyn'd Alcali; so that what the Air afforded was nothing else but meer water only.

As

As to the *quantity* of the whole Encrease it can't be determin'd by any general rule, since it varies according to the different *Strength* of the *Oyl of Vitriol* for it appears by the Table, the *more diluted* the Liquor, the *less attractive* it prov'd. This here employ'd (as highly *Phlegm'd* I presume as any usually is) gave a *triple and more than $\frac{1}{2}$* of its first weight, amounting in all from three to nine Drams, and thirty Grains before it come to a *Stand*. Which *proportion* of Encrease I found confirmed in *lesser quantities* also; as, three Grains *Encreas't* to more then nine Grains; and one Grain gave the weight of something more than three Grains. But *besides the strength of the Liquor*; there are other *Circumstances*, as the *Season* of the year; and position of the *place*, which will certainly something alter this point; thus our liquor will gain more in *Winter* than in *Summer*; more in a *Cellar* and *Sunles's Room*, than in a Room not so *qualifi'd*.

All these circumstances which relate to the *quantity* will also influence very much the *time* of the Encrease, the last thing to be consider'd in the experiment; but I shall only *mention* that which makes the most peculiar and *principal* variation in this point, and 'tis the *proportion of the Surface to the bulk of the Liquor*. For I find the *greater or less* the Surface is, the *quicker or slower* the Encrease. Thus three Grains dropt and diffus'd to nere $\frac{1}{4}$ Inch breadth on a peice of *Glaſs*, gain'd three Grains in six hours, one Grain in six more, one Grain and $\frac{1}{2}$ in twelve hours more, in the next 12 hours gained $\frac{1}{2}$ a Grain, and in the last twelve hours it gain'd very little observable; So that in less then forty eight hours, having more then triple its first weight, it was for some time *fully satiated* till *Rainy weather* added something *more*.

But to discover *more nicely* what intrest the proportion

tion of Surface has in hastening or retarding the increase of weight, I expos'd in the same Room and to the same temper of the Air (as near as I could Guess) three Drams of the same Oyl of Vitriol in an open flat Glass one Inch Broad, being only $\frac{1}{4}$ of the Diameter of that Glass us'd at first with the like quantity. The result was this ; that whereas the other Surface of *three Inches Diameter* gain'd (as in the Table) near nineteen Grains the first six hours, this *less Surface* gained a very little perceptible more then two grains in the same space of time. Now since the *Area's of Circles* are to one another as the *squares of their respective diameters*; as one the square of the *less* is to nine the square of the *greater* Glass's diameter; So was the *weight* of a little more than two Grains gain'd in the *narrower Glass* to near 19 Grains gain'd in the *broader*, wherefore the time of Increasing bears as near as can be expected an exact proportion to the Surface of the Liquor expos'd, and the liquor in the lesser Glass having but $\frac{1}{4}$ part of the Surface of the greater, could not be satiated under *nine times as many days* as the greater. From what has been said it will also follow, that if this three Drams had a Surface in the same proportion to the weight of a Sruple and a Grain viz. a little more than six $\frac{1}{4}$ Inches Diam. as that of $\frac{1}{4}$ Inch was to three Grains, the Increase of both would be *finish'd in the same time*, and would excuse the long attendance of any that shall think it worth while to *repeat* the experiment. Perhaps too the *different depth* of the Glass together with the *more or less free access* of Air ought to be *attended to* in this affair: But thus much for the *circumstances* of the experiment.

The only *use of it* I can at present find will be to *estimate moisture and dryness in the Air* which is evidently suggested by this following observation : That when the

the *Oyl of Vitriol* is satiated, in the *moistest weather*; it afterward *retains* or *looses* its acquired weight as the Air proves *more or less moist*.

Thus the one grain above mention'd after its full Increase often *varied its equilibrium*, viz. in dry weather, the *weights*, in moist, the *liquor* did constantly *preponderate*, and that so *sensibly* that the tongue of the Ballance of $1 \frac{1}{2}$ Inch long describ'd an Arch of Variation to $\frac{1}{3}$ of an Inch compass; (which Arch would have been $2 \frac{1}{3}$ Inches (had the tongue been but *one foot* in length) even with that *little quantity* of Liquor, so that if *more Liquor* expanded under a *large Surface* be us'd, the *minutest alteration of wheather* must needs very much more affect it, and a bare pair of Scales will afford *an Hygroscope* as nice perhaps as *any* yet known.

This *Ballance* may be contriv'd *two ways*, either *such* whose pin should be in the *middle of the Beam*, with a *very slender tapering tongue* of a foot or one foot and a half long, pointing to the divisions on a *broad Arch'd plate fixt above* in the handle according to *figure the third in the Table*; or else the Scale with the Liquor may be hung to a point of the Beam very near the pin, and the other extream made so long as to mark a *large Arch* on a board plac'd conveniently for that purpose, as *the fourth figure represents*; The Scale in either may be a *concave Glass* of *four or five Inch's Diameter*.

Lastly, on the division of the Arches should be inscrib'd the *different temperature of the Air shewn by the Liquor*. The fifth Figure gives the lineament of another Hygroscope made of a Viol-string running upon pulleys, and suspending a bullet fixt to the shorter end of an Index, whose other extremity is so long as to describe a *long Arch* by the *falling and rising of the Bullet* upon the *Stretching and Shrinking of the String*

which would be more nice, were the Index fastened to the center of the last pully. An experiment very obvious, but not taken notice of (as I know) by any writer, and so I thought it not impertinent to be mention'd here among *Hygroscopes*. But tis high time to conclude. I shall only add this *advertisement* that whereas in this experiment only *Oyl of Vitriol* was employ'd, I have reason to think that *Oyl of Sulphur per Campanam*, as also *Oyl of Tartar per deliquium*, and the *Liquor of Fixt Nitre &c.* may succeed as well; however, Sir, I must leave the prosecution and improvement of this and such like observations to persons who have better instruments and more leasure for such matters than,

Your humble
Servant.

W. G.